FORECASTING OF HARMFUL ALGAL BLOOMS IN THE GULF OF MEXICO*

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1.0 SUMMARY

Blooms of the toxic dinoflagellate, *Karenia brevis*, have a number of significant impacts on public health, wildlife, and tourism in the Gulf of Mexico (Tester and Steidinger, 1997). The organism is the cause of neurotoxic shellfish poisoning (NSP) in shellfish, leading to closure of shellfish beds at 5 cells ml^{-1}. At medium to high concentrations (> 100 cells ml^{-1}), the organism can cause fishkills, and lead to deaths of marine mammals including the endangered manatee. Airborne toxins can cause human respiratory distress as well. Because the blooms reappear nearly every year in the Gulf, routine monitoring and prediction are essential for public health and for anticipating wildlife response.

Management response to harmful algal blooms (HABs) of *Karenia brevis* in the Gulf of Mexico requires four types of forecasts: 1) monitoring movement of previously identified HABs; 2) forecasting the location of a HAB since the last known position; 3) distinguishing new blooms as HAB or non-HAB; and 4) predicting conditions favorable for initiation of a new HAB. Beginning in 1999, we developed bulletins to provide these types of forecast information to the states. The bulletins are based on the integration of several data sources: ocean color imagery from the SeaWiFS/OrbView-II satellite purchased and processed for coastal waters by NOAA/CoastWatch; wind data from coastal meteorological stations; field observations of bloom location and intensity provided by the states of Florida and Texas; and forecasts from the National Weather Service. The bulletins began with bloom monitoring (type 1) and limited advisories on transport (type 2). In autumn 2000, we improved the forecasts and began predicting conditions favorable for bloom development (type 4) for Florida. The state of Florida was correctly advised of the potential for a bloom to occur at the end of September (type 4) and the state was alerted to the position of previously unknown blooms in January 2000 and October 2000 (type 3). Monitoring has continued through to the present, including estimates of direction and distance of transport. The combination of warning and rapid detection are significant aids to the states in responding to these blooms.

An example bulletin from September 2001 appears in Figure 1. The bulletin includes several parts:
(a) image of chlorophyll for the Gulf of Mexico with chlorophyll processed with a Gulf of Mexico algorithm (Stumpf et al., 2000) (in the example bulletin, the bloom can be found where chlorophyll is > 2 $\mu g\ L^{-1}$ in the box);
(b) plot of wind from an appropriate location (Venice Pier in the example is at the coast where the top of the box intersects the coast);

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Figure 1. Example HAB Bulletin in 2001. Box on Florida (82W) was added. See text for more information.

Experimental Gulf of Mexico Harmful Algal Bloom Bulletin

4 September 2001

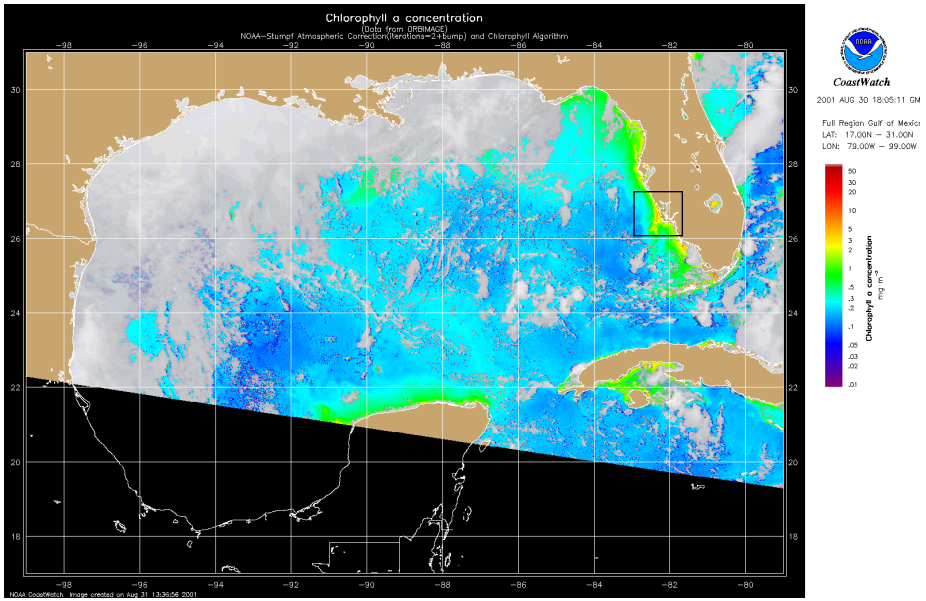
National Ocean Service/NCCOS and CSC

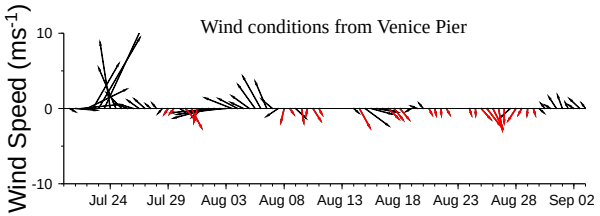
NESDIS/CoastWatch and NDBC

Last bulletin: August 30, 2001

Analysis

Bloom has intensified significantly by August 30, with concentrations over 10 ug/ L. While remaining offshore of Captive/ Sanibel, the intense bloom has moved north, and is clearly visible with > 10 ug/ L to Venice. Conditions have favored movement north over the weekend.





Wind speed and direction are averaged over 12 hours from measurements made on NOAA buoys. Length of line indicates speed; angle indicates direction. Red indicates that the wind direction favors upwelling near the coast.

Through August 30, winds were favorable for bloom development. Winds are neutral, forecast favors drift to the north.

(c) overview analysis of conditions at upper left; and
(d) analysis of relevant wind conditions below the wind plots, when appropriate.

Each 100 cell ml^{-1} of *K. brevis* has approximately 1 µg L^{-1} of chlorophyll (Tester and Steidinger, 1997). Direction of wind plays a role in redistribution of these blooms along the coast (Tester et al., 1991). The appearance and intensification of blooms along the southwest Florida coast appears to be promoted by upwelling favorable winds (Stumpf et al., 1998; Stumpf et al., in press).

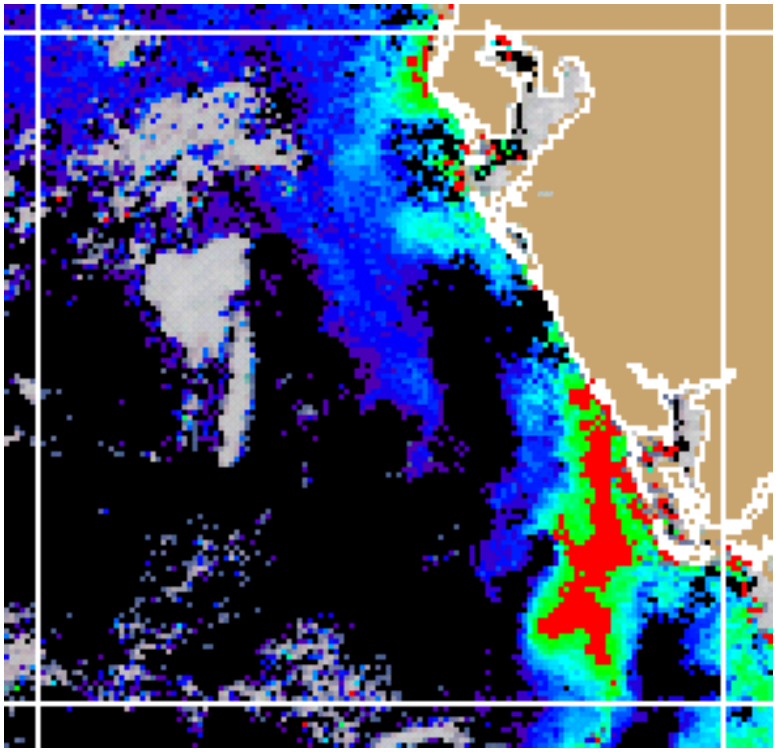


Figure 2 HAB-flag for 30 August 2001, same date as shown in bulletin and the Florida coast including Venice region (within the box of Figure 1). Red denotes probable HAB, green adjacent to red is likely lower concentration bloom.

A flagging procedure has been proposed by Stumpf (2001) and Thomas (2000), and is examined in detail for its value in Stumpf et al. (in press) and Tomlinson et al. (in press). Figure 2 shows the HAB-flag image used to evaluate the chlorophyll image in the bulletin of Figure1. The HAB-flag helps to clarify the difference between chlorophyll that is associated with the HAB and chlorophyll that is probably not. A bloom was occurring at the coast only in the area of the flag during this time. We expect that the flagging will be incorporated into the bulletins for the 2002 season.

2.0 ACKNOWLEDGMENTS

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